Leaf Proteins for Foods

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Green leaves may contain 5-10% protein, and direct extraction of certain leaves can yield up to 2,000 kg of crude protein per hectare per year. Actual yields of leaf protein vary significantly with species, variety, age, composition, and physiological state of the plant; length of postharvest period; drying treatment; degree of maceration of leaves; solvation ratio; pressure applied; solvent(s) used; additives (ammonia, bisulfite); duration, pH and temperature of extraction; separation techniques; number of extractions; method of precipitation (acid, salt, heat); method of recovering and drying the protein. Protein recoveries range from 40-80%, with the better methods yielding 60% of the original leaf protein. Good extracts contain 65-70% protein, i.e., leaf protein concentrates (LPC); up to 10% lipids and around 6.0% ash. Further refining may yield protein isolates with over 90% protein.

The term LPC has been applied to leaf proteins prepared from numerous different plants by a variety of methods, hence claims about properties and effects of leaf protein (LP) may not be generally valid because of variations in composition. Extensive research has shown that LP has potential as a source of food protein. However, LP need not and should not be considered as a sole source of dietary protein, rather it initially might be introduced as a supplementary source of protein to complement other conventional food sources. In considering the use of LP, knowledge of the eating habits and preferences, technological and educational status, educational level and motivation of the target consumer is important. Before their general introduction, leaf preparations must meet a number of critical criteria, e.g., organoleptic, functional, nutritional and safety properties.

Assessment of nutritional value has been a major preoccupation of many researchers studying LP. LP from many plant sources possess a good amino acid composition, being apparently deficient in only methionine. Methionine and lysine, being quite reactive, are easily destroyed during extraction, drying, and storage. Heating and storage in the presence of oxidizing lipids reduce the concentration of these amino acids and result in LP of inferior nutritive value. Discrepancies between in vitro digestibility studies (pepsin/trypsin or pancreatin) are largely due to different methods of extraction, refining, precipitation, washing, drying, and storing. These affect the composition (e.g., protein content, antitryptic factors) of the LP preparation. The more refined (low yield) LP are very digestible and appear to have a well balanced amino acid composition. Numerous feeding trials have reported PER values ranging from 1.5 to 2.5. These vary with protein preparation. Supplementation of LP with methionine (.02%) and lysine increases PER values to 3.0. Trials with human subjects have demonstrated the value of LP as a supplementary source of dietary protein, and the amino acids present indicate its value for complementing cereal-based diets.

In developing LP for foods (or feeds for monogastric animals) appropriate processes for eliminating the antinutrients (trypsin inhibitors), toxins (cyanogenic glycosides in cassava, thioglycosides in brassica, goitrogenic compounds, alkaloids), and physiologically active compounds (oestrogenic materials, photosensitive molecules) that may be present in the original leaves must be incorporated.

Much of the research on LP has not been conducted with a specific objective in terms of utilization as a food ingredient; rather, localized use as a condiment or supplement has been envisaged. However, for ultimate widespread acceptance and use by food manufacturers and consumers, leaf proteins like conventional and food proteins must have appropriate functional properties. Functional properties is a collective term for those physicochemical properties of proteins which determine the overall behavior or performance of proteins in foods during manufacturing, processing, storage, preparation, and consumption. They reflect those properties of the protein per se and its interactions with other food components as affected by the immediate environment. The particular functionality required varies with each food application, and of course no single protein can perform all of these functions.

Ideally, leaf proteins should have good nutritional value, satisfactory color, odor, flavor, and texture, but they also should possess additional functional properties, e.g., solubility, surface activity, coagulability, thermal stability, adsorption properties, etc. for successful performance in a variety of applications in foods. These criteria are frequently overlooked when considering new proteins where yield and biological value are emphasized. The successful supplementation of traditional foods, the replacement of protein in or the simulation of traditional proteinaceous foods, and the fabrication or engineering of new foods will depend on the availability of new proteins possessing the requisite functional properties. Thus, leaf protein to be adopted by the food industry and to gain general consumer acceptance must possess appropriate functional properties.

Additional research on leaf protein is needed to develop improved methods for protein extraction; to develop refining procedures for removing undesirable colors and flavors that are compatible with retention of reasonable functional properties; to establish nutritive value and safety and to develop and demonstrate acceptable applications. When such information is available, consumer and political acceptability may be more accurately assessed, and more definitive economics can be considered.